SMART CROP SUITABILITY SYSTEM

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Department of Information Technology

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DECLARATION OF THE CANDIDATE & SUPERVISOR

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ABSTRACT

Among leading revenue industries in Sri Lanka, Agricultural industry plays a strategic role in the process of economic development of our country. One of the significant issues currently in the industry is deprive an accurate way to realize the most suitable crop that can be grown in a particular land and soil degradation due to excess fertilizer usage. This research mainly focuses on suggesting the best crop that can be grown in a particular land with the existing nutrient levels in soil and a better fertilizer plan for better harvest. Nutrient levels in soil affect growth of a plant and farmers have lack of knowledge about those nutrients. Currently most of the farmers cultivate crops by believing myths in society and few of them use scientific approaches. Believing myths is risky because those crops may not always be the most suitable crop to grow in that land. For scientific approaches, farmers need to test soil samples with the help of agricultural department. It is costly and time consuming. Also it can’t be considered as the overall soil result of that land. Authors build a tool with embedded sensors that measure nutrient levels in soil which affects the growth of a plant and deploy a cross platform mobile application which facilitate to identify the best crops that can be grown according to available nutrients in soil. Addition to that, a fertilizer plan will be suggested. Soil samples in a new land are tested using our system by applying app suggested fertilizers in necessary amounts to that soil. Then compare the result with a soil samples in areas where a particular plant is well growing to evaluate our final product.

Keywords – Crop, Fertilizer, Soil nutrients, Soil degradation, Harvest

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1. INTRODUCTION

1.1.Background Literature

As noted in Nutrient Management Modules 2 to 7, soil pH and organic matter powerfully have an effect on soil functions and plant nutrient convenience. Specifically, pH influences solubility and convenience of plant nutrients, performance of pesticides (which embody herbicides), and organic matter decomposition. Though soil (approximately the highest 4 to 6 inches) pH is mostly similar in Montana and Wyoming (pH 6.5-8.0), it will vary from 4.5 to 8.5, inflicting tidy fertility and production challenges at these extremes. Therefore, to grasp nutrient convenience and best growing conditions for specific crops, it's vital to understand factors that have an effect on soil pH, and also the effects of pH on nutrient convenience.

In July 2017 group of researchers Sabina Rahaman, Harshitha M, Anusha R, Bhargavi Y [1]R, Chandana M from Department of Electronics and Communication Engineering BMS Institute of Technology, Bangalore 560064 have invented a research which detect NPK Ratio Level Using SVM Algorithm and Smart Agro Sensor System They have integrated a sensing module with an Image processing setup to monitor the essential details needed for plant growth from the soil.

As inputs they have get Temperature/Humidity, Soil Moisture and pH level. Which means those things directly affect to the fertilizer level of the soil. Furthermore, Image Acquisition, enhancing the image using Grey scale analysis, Adaptive Histogram analysis and feature extraction Methods have used by the research team for better result

They have analyzed These feature values comparisons with database feature extraction and Mutism is used to classify into ratio level of NPK indicating which Nutrient is low. And also, they have successfully Given moisture level(dry/wet) of soil, humidity reading, and pH scale. [1]

Mr. Khakal V.S., Mr. Deshpande. N. M , Mr. Varpe P. B. Department of E &TC , PDVVP COE Ahmednagar have research Measurement of NPK from PH value and they have used NPK Microsensors other than ph and temperature sensor and mainly they have prepared a desktop application for view the results so in our system it will be more user friendly to using a smart application. [2]

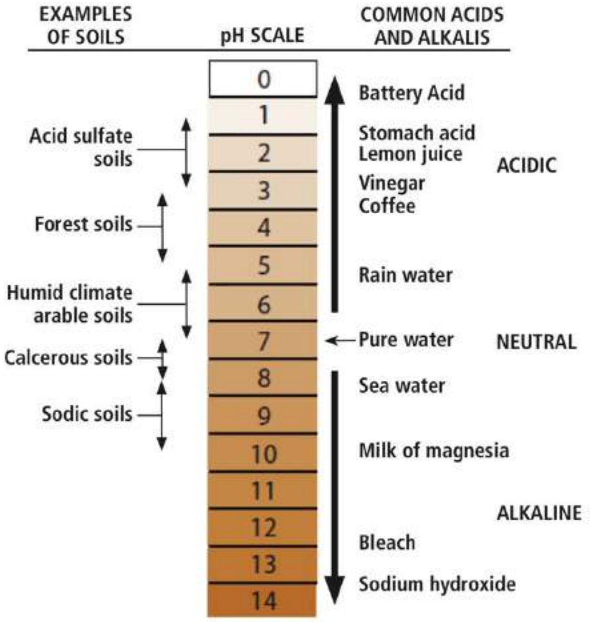

Figure 1- The pH scale[3]

Fertilizer level variation with humidity:

All fertilizers more or less hygro- scope which suggests that they begin ab- sob wet at a particular humidity or at an explicit water vapor pressure.

Some terribly absorptive fertilizers at- tract moisture rather more promptly and at lower humidness than others. Water absorption takes place if the water vapor pressure of the air exceeds the vapor pressure of the fertilizer.

Absorption of moisture during storage and handling will reduce the physical quality. Knowing at which humidity the grades start to absorb large quantities of water is very important.

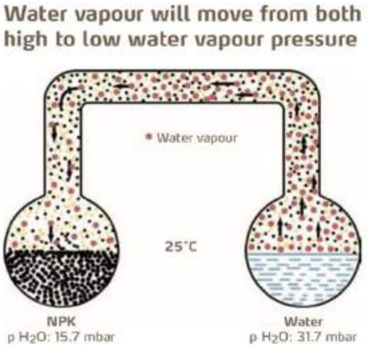

Figure 2-water vapour vs NPK[4]

In sri lanka there are both laboratory testing for pH and digital pH testing currently used. other than other countries all around the world sri lanka have high variation of pH and humidity so that it is a hard task to give a medium value for pH or humidity [5]

A group of researchers Komal Abhang, Surabhi Chaughule, Pranali Chavan, Shraddha Ganjave has done a research on soil analysis and crop fertility prediction after referring results gathered by testing the particular ground soil by normal lab tests done by the agricultural department.

The main aim of our System is to Atomize current manual soil testing procedure. In our system we are building handheld device using pH meter which will give pH value of soil. pH is negative log of hydronium ion mole per liter pH = - log [H3O+]. With help of this pH value we will estimate NPK of that soil, which are necessary Macronutrients of soil.

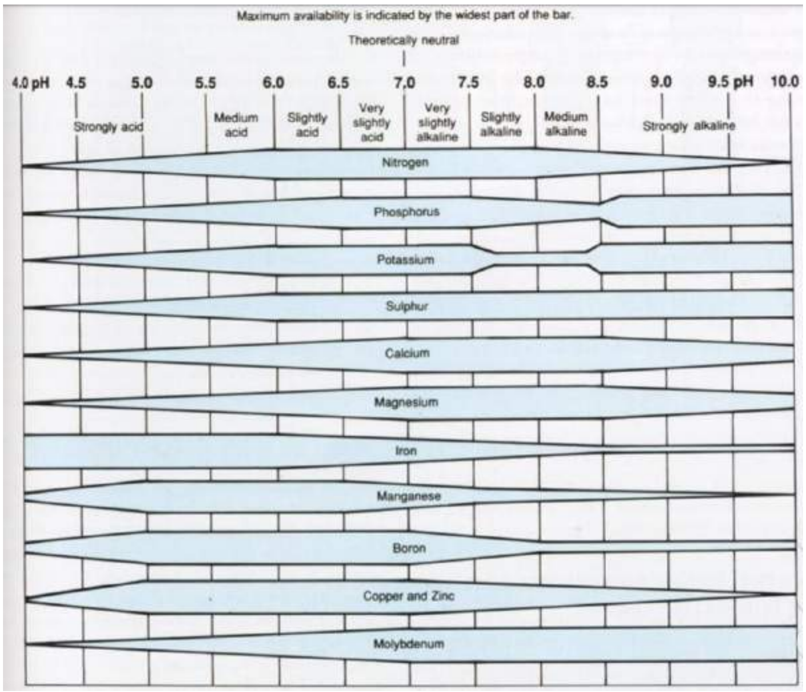

Figure 3 - Nutrients present at particular pH value [12]

These will decide fertility of soil. For our software model we will be training crop database and we will classify that particular soil sample into particular class using classification algorithm. Depending on class determined by our system we will give list of crops suitable for that particular soil sample. Also provide suggestion of fertilizer for particular crop.

Nitrogen, phosphorus, and potassium are the main components of soil fertilizer. These methods isolate each nutrient from the soil into a solution that can be analyzed using turbidity and color to determine the concentration of nutrients present in the soil sample. Knowing present concentration informs environmental scientists of a nutrient deficiency or surplus in soils used to support plant production, and also provides general insight into basic biogeochemical cycles of an ecosystem.

Traditional soil testing presents a nearly insurmountable problem for farmers of small parcels. A second simplification tool for site-specific nutrient management for small farmers is the soil test kit. Access to soil test results such as those used to develop maps of soil properties are very difficult or impossible for farmers of small land parcels. Soil testing laboratories often do not even exist in most developing countries of the tropics. The soil test kit is not intended to serve as a replacement for standard soil testing but designed to enable extension officers and farmers to diagnose nutrient extreme deficiencies and excesses. Even when standard laboratories are available, the delay between sample collection and when the results are received may often preclude use of the results in the fertilizer decision making. It is an unusual farmer manager who anticipates the fertilization decision and sends in a soil sample in preparation for the decision.

The soil test kit permits obtaining a measure of soil pH, nitrate and ammonium, phosphorus, and potassium within about 30 to 45 minutes and can short-circuit the lengthy delays typical of soil testing Many soil scientists disbelieve the results from soil test kits, sometimes with good reason. Seldom is there sufficient training or any training at all with commercially available test kits and seldom are users given the information about which steps of the determination are critical and which are not [1]. For example, identified through the Participatory Learning Forum, have been successfully taught to use soil test kits as part of the site-specific nutrient management process described herein

Granary	Location (Season)	FERTO Rate				Farmer Rate		
		N	P_2O_5	K_2O	CM (kg/ha)	N	P_2O_5	K_2O
MADA	Kobah (1/2000)	197	95	150	1568	135	75	55
KADA	Ketereh (1/2001)	137	49	129	3400	149	89	69
	Meranti (1/2002)	188	85	195	3400	192	110	124
	Meranti (2/2002)	124	94	221	2393	192	110	124
	Meranti (1/2003)	124	94	221	800	192	110	124
	Senor (1/2003)	149	95	222	2418	150	90	70

Figure 4- FERTO package and farmer fertilizer rates used in the study locations [12]

Fertilizer recommendation rate [12]

Figure 2 shows the fertilizer recommendation rates that were generated by FERTO package for plots in MADA and KADA areas, based on the physico-chemical properties of the soils and the set yield target. The recommendations had fertilizer rates ranging between 124 and 197 kg/ha for N, 45 and 95 kg/ha for P_2O_5, 129 and 222 kg/ha for K_2O, and between 800 and 3400 kg/ha for chicken manure (CM). Generally, potassium fertilizer and chicken manure are recommended in higher amounts for crop in KADA, than in MADA. It is due to low potassium and cation exchange capacity (CEC) status of KADA soils, thus inability to enhance high yield. Soils originating from riverine alluvium with 1:1 parent material clay like KADA are generally of low inherent fertility status. MADA soil with marine 2:1 clay are always better in fertility status as indicated by their high organic matter content and CEC status. These two parameters are important to ensure that the fertilizer applied can be held by the soil before it can be taken up by the crop. Otherwise, the crop has less opportunity to absorb the applied fertilizer because most of it will be lost through leaching process.

Normally, applied fertilizer is recommended to be split into various applications timing to optimize crop nutrient uptake and minimize loss through leaching and evaporation processes. Therefore, FERTO package recommends four split applications, i.e. basal dressing, first top-dressing, second top-dressing, and final top-dressing during specific crop growing stages. For basal application, compound fertilizer (15:15:15) at a blanket rate of 200 kg/ha was applied at seedling stage, about 15 days after seeding (DAS). Split applications of straight fertilizers for top-dressing were varied according to locality, depending on the rates recommended by FERTO package (Abd Razak *et al.*, 2004). Chicken manure, if recommended, will be applied at early tillering stage, about 25 DAS. Fertilizer rate for each split application will be calculated by the model as formulated in the knowledge base. High N and K_2O rates were recommended at vegetative and reproductive stages, respectively. This will ensure development of quality tillers and productive panicles to attain high yield performance [1].

The researchers Joon-Goo Lee and Haedong Lee, Aekyung Moon in Electronics and Telecommunications Research Institute, Daegu, Korea has done a research on monitoring and the prediction of crop growth by using image processing technique.

They have gathered the required information such as location, size, leap area index, canopy of the crop and suggested the effective segmentation method of Crop of Interest (COI) at horticulture greenhouse. They have proposed to do their research in two ways. Such as,

- A colour image of the crop is segmented the green and non-green region.
- A depth image of the crop is removed near crops as rear crops and both sided crops.

They have tried to overcome the problems in the existing methods which use threshold of each colour channel. So to overcome those errors they have suggested to use a ratio of each colour channel that is strong on changeable illuminance. [4]

Researchers, B. MiloviC and V. RadojeviC has done a research on the importance of data mining in Agriculture. In order to maintain the growth of the selected crop and generate a fertilizer plan we need to handle widely distributed data set with the nutrient levels the plant need in different time periods. So data mining technique will be useful to organize the data set and gather the required data by using patterns and algorithms.

There are many types of data mining techniques we can use for agriculture according to their research. [5]

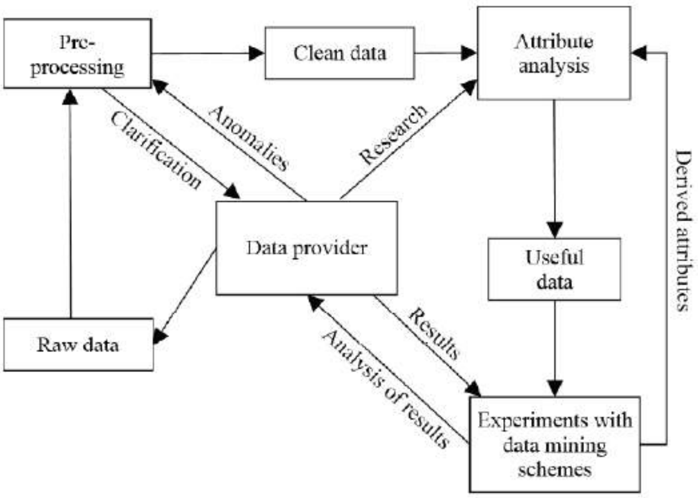

Figure 5- Process model for a machine learning [5]

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Now a day's people are so busy with their day-to-day works, they have a very limited time to fulfill all the responsibilities. So that they tend to use the things which helps to save their time to do their daily tasks. They have increasingly used to depend on machinery, rather than doing the things manually. Recently this technique got more popular in cultivation field too. Earlier days farmers had to use so much human power to fulfill their needs in cultivation. But now using a single machine alone with only one person to control it can gain the same amount of work with lesser time and lesser money.

Knowing the conditions which are required to grow the plant we desired to grow is the key point of a successful cultivation. For that we need to know very well about the soil type we are dealing with as well as the environmental conditions. Environmental conditions are not easy to change if we are assuming to start an outdoor plantation. But we can apply different nutrient types that helps to grow the plants well which leads to have a successful result. To identify the soil better in that specific ground, we can perform a soil test. Soil test is basically a series of tests which helps to identify the nutrient level of the soil.

Now a days, the most trusted soil testing mechanism is testing the soil with the help of professionals in the nearest laboratory. But majority of the people don't have enough time to visit the laboratories or can be a beginner without much knowledge about cultivation. So they will believe the myths people say about the best crops for a particular area and grow it without thinking much.

Maybe trying plantations with believing myths will be a success, but we cannot guarantee that it is the best option that someone can decide on. The soil conditions will vary with the time. So it will be helpful if the owner can get notify time to time with a nutrient plan which helps to adjust the soil to gain more results from the ground.

According to a research by Department of Economic and Social Affairs in United Nation, New York, the current world population of 7.3 billion is expected to reach 8.5 billion by 2030 and 9.7 billion in 2050 [4]. So the amount of the people who need to feed will be increased day by day. Therefor we need to have a better cultivation system than the manual, traditional system.

If there is a way for people to identify the best plant according to the environmental conditions in the area and the soil type of their ground by their own, it will be a very helpful solution for the better results and to saves time.

The proposed system is basically based on using Internet of Things (IOT) and so that it leads to use technology on fulfilling cultivation purposes effectively and efficiently

K-mean in Agriculture:

The K-means algorithm is distance based clustering techniques. By applying this algorithm, K cluster are formed. Based on Euclidean distance, object is placed into the respective cluster. The k-means algorithm is used to classify soil in combination with GPS. Classification of plant and soil, grading apples before marketing, Monitoring water quality change, detecting weeds in precision agriculture, and the prediction of wine fermentation problems can be performed by using a k-means approach.

K-nearest neighbour in Agriculture:

In pattern recognition, the k-Nearest Neighbours algorithm is a non-parametric method used for classification and regression. In Agriculture, k-NN algorithm is used in simulating daily precipitations and other weather variables and Estimating soil water parameters and Climate forecasting.

Neural Networks in Agriculture:

In data mining a statistical model known as Artificial Neural Network is a Non-linear predictive model that learns through training and resembles biological neural networks in structure.

The neural network is used in Prediction of flowering and maturity dates of soybean and in forecasting of water resources variables in agriculture.

SVMs in Agriculture:

Support vector machine (SVM) which was originally developed by Vapnik (1998) has been widely applied to many different fields, such as signal process and time series analysis.

SVMs are one of the newest supervised machine learning techniques.

The current study investigated the applicability of support vector machine in agriculture is in the crop classification and in the analysis of the climate change scenarios.

Decision Tree in Agriculture:

Decision Tree is tree-shaped structures that represent sets of decisions and generate rules for the classification of a dataset. Specific decision tree methods include Classification and Regression Trees (CART) and Chi Square Automatic Interaction Detection (CHAID).

In agriculture, Decision tree algorithm is used for predicting soil fertility.

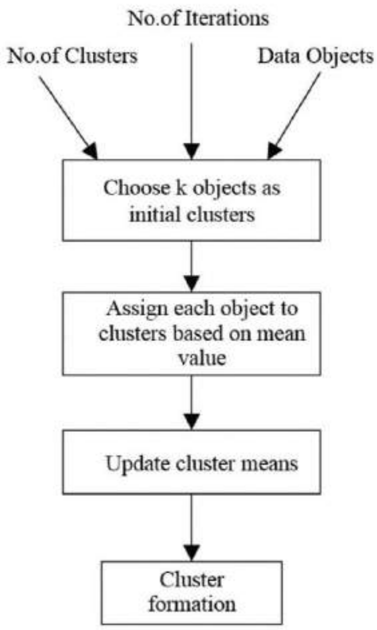


Figure 6 - Cluster formation using k-means [3]

- **Deep Learning**

  Deep learning technique, which teaches the computer to filter inputs through layers in order to predict and classify information, has become really popular lately. It is mainly use neural network architecture, which are organized in layers consisting of a set of interconnected nodes. These networks can have tens or hundreds of those hidden layers.

  Deep learning models are trained by using sets of labelled data and neural network architectures that learn features directly from the data without the need for manual feature extraction. [6]

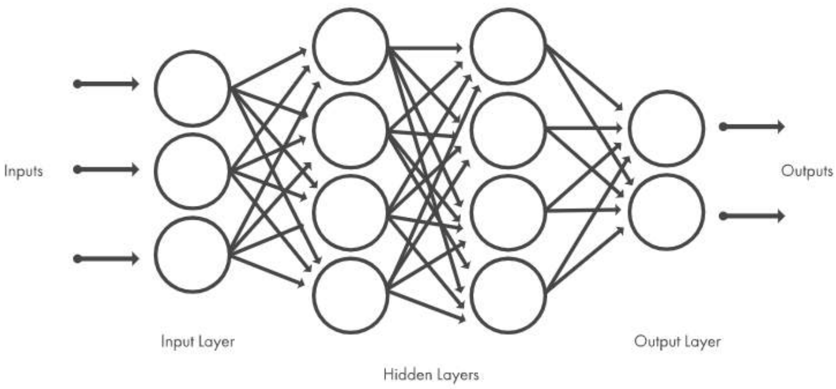


Figure 7 – Neural network structure

1.2 Research gap

Based on the literature survey, there are significant amount of research projects that has been carried out according to this research that has described throughout this report.
Almost all of the projects were carried out by doing laboratory tests with using various chemicals or using expensive sensors to check the nutrient levels in the soil. But to do a laboratory tests, people has to carry out the soil samples to the agricultural departments and it needs much time and cost. So we have decided to develop a tool with attaching sensors which will test the main factors like electrical conductivity (EC) and humidity of the soil.

According to the literature review, we have realized that using sensors to test the nutrient factors of the soil will lead to spend the user a lot of money. But we are planning to make this proposed solution which can be used by many users with spending less money. So we are planning to test the soil nutrient factors such as Nitrogen (N), Phosphorus (P), and Potassium (K) as respect to the values of changing pH levels.

Some researchers have gathered the soil samples by taking it in different layers from the same place in the ground. But we are going to use the zig-zag soil testing method which needs to take soil samples from the different places in the ground in a zig-zag pattern. Using this method will be helpful to generate a most correct result about the soil nutrients as it tests the soil types through the whole ground.

The system that the researchers Joon-Goo Lee and Haedong Lee, Aekyung Moon has done using image processing techniques. But to gather image information about a specific ground, it requires to have specific people that are specialized in that area.
The researchers, B. MiloviC and V. RadojeviC has been carried out their system by using data mining techniques according to the lab test results of the ground.
Both of those approaches need specific people who has specialized in the area of image processing or the chemists who needs to perform the lab tests according to the soil samples that the farmer has provided, and needed more time and money to get the soil nutrient details in a ground.
In fact, these applications are not suitable for Sri Lankan farmers, since each farmer cannot afford lots of money in the beginning of a cultivation. Also the farmers will satisfy if they have the ability to test soil as quickly as possible

1.3 Research problem

When concluding the study of existing methods use by farmers to select the suitable crop for a particular land, we have realized that there is major problem that should take in to account which is not having an accurate and proper way to know the most suitable crop for a particular land/state. Since we are evolved with the technology, we finalized that it is better to have proper system that can be utilized in agriculture field efficiently in order to overcome this problem.

Analysing soil before starting a cultivation is an important fact as soil nutrients are one of the major factors that affects growth of a plant. Some plant is sensitive to alkalinity and acidity of the soil and may not give a better harvest if failed to fulfill the needed conditions. Practically farmers have lack of knowledge about soil nutrient levels and also there is not an easy way to analyze soil nutrient levels in a land. Because of that in the existing system, most of the farmers start their cultivations by believing myths in society. Believing myths is risky because crops related to myths may not always be the most suitable crop to grow in that particular land. As well as believing myths is useless if the land is filled with new soil. So farmers fail to achieve better harvest with the existing soil nutrients.

In addition to that, very few of farmers use scientific approaches to identify the most suitable crop for the land. For that farmers need to test soil samples with the help of agriculture department. People need to travel long way to test soil in their land by giving soil samples to agriculture department and it is not an efficient way as lab test may take days to give results. Also it takes very large cost and as well as we can’t consider it as the overall soil result of the land as nutrient levels in a land varies from point to point. It may cause wasting of both time and money of the farmer.

Other major problem is soil degradation occurs due to not identifying the best crop that can be cultivated in a particular land with minimum fertilizer usage. When farmers fail to identify the suitable crop for existing soil nutrient levels in land, they have to use more fertilizer which affects soil health badly.

New cultivators who are new to agriculture industry are facing many problems as they do not have a broad knowledge about cultivations. If they failed at the beginning, they won’t engage in agriculture industry further. So it better for both farmers and inexperienced beginners to have a more accurate and efficient solution to identify best crop that can be grown in a particular ground and a parallel fertilizer plan according to the existing soil nutrients, as it avoids wastage of their both time and money.

1.4 Research objectives

The main expectation of this project is to develop a fully functionally mobile app which capable to suggest the suitability of land to seed crops. This app is mainly focus on agricultural peoples who wish to seed new crops in a new soil land which hasn't seed particular seed before. By using the app people will be encouraging to seed smarter using recommended fertilizer levels with most suitable crop to the particular land. To use by any person to start their own plantation

- To estimate fertility status of soil and can easily identify the best crop that can plant in that land.
- To change nutrient level in soil according to crop we need to grow. So, can gain good result.
- To use by any person to start their own plantation.
- To provide a basis for fertilizer recommendation for a given crop.
- To reduce the risk of not being able to have good result from plantations.
- To make people encouraged to start plantation more.
- Save the soil by applying the accurate amount of fertilizer
- To estimate fertility status of soil and can easily identify the best crop that can plant in that land
    - Using the sensor readings and compare them with relevant data sets people can identify the best option for plant, we gather data sets to maintain best environment and fertility levels for main commercial crops such as paddy, rubber, coconut and tea.
- To change nutrient level in soil according to crop we need to grow. So, can gain good result
    - Using this method, we can reduce the failure of plantations according to law and unbalance fertility level. Most common method in current using is believe in myths. But with the relevant information farmers have more confidence to

plant and they can check and maintain plantation with major stages of the crop in case of low growing.

- To use by any person to start their own plantation
    - With the help of this method famers can start plantation without having any basic knowledge about the crops they going to plant. So that most of time and cost is reducing with the help of this method. As an example, farmer only want a minimum knowledge about operate the tool. It will suggest everything which necessary to plant the relevant crop. In the beginning of plantation every farmer may have doubts about the fertilizer levels. In present, farmers have to go for agriculture department with soil samples and do lab test which take couple of days. But with the help of this method
- To provide a basis for fertilizer recommendation for a given crop
    - In plantation there are several stages which passing by the plant. so that requirements of fertilizers for plants can be vary. As an example, phosphorus percentage is more needed for plants when they come to their blooming stage. Farmers will get know what's the exact fertilizers should give more in particular stages.
- To Reduce the risk of not being able to have good result from plantations
    - By maintaining recommended fertilizer levels plants will go through their growth stages with rich required fertilizer percentages. Therefore, it will reduce the risk of failure in plantations.
- To make people encouraged to start plantation more
    - Most of people are not start plantation because of the doubts about plant growth and if any case they have to go for advises to agriculture departments. Using this tool, no need to wait for lab test results of soil testing's, can easily identify the relevant fertilizer levels and the people are encouraged to plant more. Its easy to use and easy to handle and quick responsible.

- Save the soil

Most of people don’t have an idea about how much we apply fertilizers on land. Therefore, they might apply over the limit and soil can be damaged by it. Using the app will show the exact amount we should apply and it will be the recommended amount of fertilizer for both plant and soil.

2. METHODOLOGY

2.1.Methodology

In this research we are basically planning on focusing the nutrient levels in soil from different areas in Sri Lanka. Because there are many varieties in the soil in our country, there is a huge variety of soil types in Sri Lanka.

As we utilizing pH sensors and moistness sensors, we have to get readings as parameters for fabricate the co-relationship which make the bury association between datasets.to get the readings and store them we use raspberry pi board as our principle sensor center point.

In horticulture, the pH is likely the most vital single property of the dampness related with a dirt, since that sign uncovers what yields will develop promptly in the dirt and what alterations must be made to adjust it for developing some other harvests.

Figure 8 – pH sensor

pH sensor:

Moistness is the sum of water vapor noticeable all around. To an extreme or too little humidity can be hazardous. For instance, high humidity joined with hot temperatures is a blend that can be a wellbeing hazard, particularly for the extremely youthful and the exceptionally old.

Figure 9 – Humidity sensor

Humidity sensor:

DHT11 is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programs in the OTP memory, which are used by the sensor's internal signal detecting process. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to-20-meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package.

Raspberry pie:

Raspberry pi work as a small computer and compound with a microSD card, and a power supply and we can connect a suitable display using a HDMI cable if need.

And can be used as a traditional computer, using USB keyboard and mouse. and also pi board has an integrated WIFI module which can connect internet. Therefore, we can easily upload our datasets to a cloud server.

Figure 10 – Raspberry Pi b+

To build the co relationship between pH, humidity with fertilizers need to do some lab tests.

Nitrogen (N) assurance in the research center as per John Kjeldahl (1883) technique:

Test pre-treatment: It is essential that all examples to be pretreated to consent to the standard in the field of soil. Care was taken amid the processing so that not to misfortune measure of nitrogen, in this way, the temperature was under 400°C. The methodology: Right off the bat, the homogeneity of the research facility test just as the test was ensured.

Digestion:

Dried and crushed example segment of 0.2 gram (expected nitrogen content equivalent to 0.5%) to one gram (expected nitrogen content roughly 0.1%) was utilized. At the point when 10 ml sulfuric corrosive (4.2) was included, whirled until the corrosive was altogether blended with the example. The blend was permitted to represent cooling. At that point 2,5 g of the impetus blend 4.3 was included and warmed till the assimilation blend turned out to be clear. The blend was bubbled delicately for 5 hours to permit the sulfuric corrosive gathers around 1/3 as far as possible of the cylinder. The temperature of the arrangement was kept up underneath 400 °C

Titration:

After processing was finished, the cylinder was left to cool; and 20 ml of water was included with gradually shaking. At that point the suspension was exchange to the refining device 5.4. At the point when; 5 ml of boric corrosive 4.5 was added to a 200 ml cone shaped jar and set under the condenser of the refining contraption so that the finish of the condenser dunks into the arrangement. At that point 20 ml of sodium hydroxide 4.4 was added to the pipe of the mechanical assembly and ran the antacid gradually into the refining chamber. From that point, around 100 ml of condensate was refined, wash the finish of the condenser, at that point few drops of blended marker 4.6 were added to the distillated and titrated with sulfuric corrosive 4.7 to a violet endpoint. Steam refining was utilized. Refining was ceased when 100 ml of refining was gathered.

Calibration:

Adjustment substances with known and unchangeable substance of nitrogen were utilized to control the processing and the mechanical assembly. Sulfanil corrosive with realized nitrogen content was utilized. Other than these substances ensured reference materials were utilized also to control the entire method

Blank assurance:

Two clear conclusions were done in every arrangement and the normal clear esteem was utilized for ensuing estimations.

Duplicate assurance:

From the submitted test for examination, two sub-tests were tried. Control limit for contrasts between the aftereffects of the tow sub test was built up, and exactness was resolved.

Method of figuring:

The substance of nitrogen, (wN), in milligrams per gram was determined utilizing the equation:

$$wN = (V1 - V0) \times c(H+) \times MN \times 100 / m \times mt$$

Where,

V1 is the volume in millimetres of sulfuric corrosive (4.7) utilized in the titration of the example. V0 is the volume in millilitres, of the sulfuric corrosive (4.7) utilized in the titration of the clear test c (H+) is the centralization of H+ in the sulfuric corrosive (4.7) in moles per liter (for example in the event that 0.01 mol/l sulfuric corrosive is utilized, c(H+) = 0.02 mol/l). MN is the molar mass of nitrogen in grams per mole (=14) m is the mass of test mt is the dry build up, communicated as g/100g based on stove dried. [7]

Assurance the phosphorous level in the soil:

To separate Phosphorus, all around shacked 1 g of air-dried soil in 10 mL of 0.025 M HCl and 0.03 M NH4F for 5 minutes was readied. Phosphorus was resolved on the filtrate by the molybdate-blue strategy utilizing ascorbic corrosive as a hesitant. Shading improvement was estimated at 880 nm on a Brinkmann PC 800 test colorimeter. [8]

Some specific recommendations for soil analysis are summarized here: [15]

1.Soil samples must be representative of the land area in question. The recommendation is to take a minimum of one composite sample per 12–15 ha for lime and fertilizer evaluations. A representative soil sample is composed of 15–20 subsamples from a uniform field with no major variation in slope, drainage, or past fertilizer history. Any of these listed factors, if changed, will have an effect on the number of samples and unit area from which the sample is obtained;

2.Depth of sampling for mobile nutrients such as N should be 60 cm and, for immobile nutrients such as P, K, Ca, and Mg, 15–20 cm. For pasture crops, a sampling depth of 10 cm is normally sufficient to evaluate nutrient status and make liming and fertilizer recommendations;

Electrical Conductivity (EC) [16]

The preferred index to assess soil salinity is electrical conductivity. Electrical conductivity measurements are reliable, inexpensive to do, and quick. Thus, EC is routinely measured in many soil testing laboratories. The EC is based on the concept that the electrical current carried by a salt solution under standard conditions increases as the salt concentration of the solution increases. A sample solution is placed between two electrodes of known geometry; an electrical potential is applied across the electrodes, and the resistance (*R*) of the solution between the electrodes is measured in ohms. The resistance of a conducting material (e.g., a salt solution) is inversely proportional to the cross-sectional area (*A*) and directly proportional to the length (*L*) of the conductivity cell that holds the sample and the electrodes. Specific resistance (R_s) is the resistance of a cube of a sample volume 1 cm on edge. Since most commercial conductivity cells are not this large, only a portion of R_s is measured. This fraction is the cell constant ($K = R/R_s$). The reciprocal of resistance is conductance (*C*). It is expressed in reciprocal ohms or mhos. When the cell constant is included, the conductance is converted, at the temperature of the measurement, to specific conductance or the reciprocal of the specific resistance (Rhoades, 1993). The specific conductance is the EC (Rhoades, 1993), expressed as

(10.2)EC=1/Rs=K/R

Electrical conductivity is expressed in micromhos per centimeter μmho cm^{-1}) or in millimhos per centimeter (mmho cm^{-1}). In SI units the reciprocal of the ohm is the siemen (S) and EC is given as S m^{-1}or as decisiemens per meter (dS m^{-1}). One dS m^{-1} is one mmho cm^{-1}. The EC at 298 K can be measured using the equation

(10.3)EC298=ECtfv

Where f_t is a temperature coefficient that can be determined from the relation $f_t = 1 + 0.019$ (t-298 K) and t is the temperature at which the experimental measurement is made in degrees Kelvin (Richards, 1954).

A number of EC values can be expressed according to the method employed: EC_e, the EC of the extract of a saturated paste of a soil sample; EC_p, the EC of the soil paste itself; EC_w, the EC of a soil solution or water sample; and EC_a, the EC of the bulk field soil (Rhoades, 1990).

The electrical conductivity of the extract of a saturated paste of a soil sample (EC_e) is a very common way to measure soil salinity. In this method, a saturated soil paste is prepared by adding distilled water to a 200- to 400-g sample of air-dry soil and stirring. The mixture should then stand for several hours so that the water and soil react and the readily soluble salts dissolve. This is necessary so that a uniformly saturated and equilibrated soil paste results. The soil paste should shine as it reflects light, flow some when the beaker is tipped, slide easily off a spatula, and easily consolidate when the container is tapped after a trench is formed in the paste with the spatula. The extract of the saturation paste can be obtained by suction using a Büchner funnel and filter paper. The EC and temperature of the extract are measured using conductance meters/cells and thermometers and EC_{298} is calculated using Eq. (10.3).

The EC_w values for many waters used in irrigation in the western United States are in the range 0.15-1.50 dS m^{-1}. Soil solutions and drainage waters normally have higher EC_w values (Richards, 1954). The EC_w of irrigation water < 0.7 dS m^{-1} is not a problem, but an EC_w> 3 dS m^{-1} can affect the growth of many crops (Ayers and Westcot, 1976).

It is often desirable to estimate EC based on soil solution data. Marion and Babcock (1976) developed a relationship between EC_w(dS m^{-1}) to total soluble salt concentration (TSS in mmol liter^{-1}) and ionic concentration (C in mmol liter^{-1}), where C is corrected for ion pairs. If there is no ion complexation, TSS = C (Jurinak and Suarez, 1990). The equations of Marion and Babcock (1976) are

(10.4)logundefinedC=0.955+1.039undefinedlogundefinedECw

(10.5)logundefinedTSS=0.990+1.055undefinedlogundefinedECw.

These work well to 15 dS m^{-1}, which covers the range of EC_e and $EC_w$for slightly to moderately saline soils (Bresler *et al.*,1982).

Griffin and Jurinak (1973) also developed an empirical relationship between EC_w and ionic strength (*I*) at 298 K that corrects for ion pairs and complexes

(10.6)I=0.0127undefinedECW

where EC_w is in dS m^{-1} at 298 K. Figure 10.2 shows the straight line relationship between *I* and EC_w predicted by Eq. (10.6), as compared to actual values for river waters and soil extracts.

There are few sensors that essential for this research. There are pH, humidity, temperature, EC.

Temperature Sensor

Figure 11 – Temperature sensor *[Source: Google]*

Soil temperature sensors arrive in an assortment of structures utilizing thermistors, thermocouples, thermocouple wires, and averaging thermocouples. The electrical signs transmitted from the sensors to information lumberjacks can be changed over to various units of estimation, including °C , °F, and °K. Information lumberjacks are likewise equipped for estimating most financially accessible soil temperature sensors.

EC sensor

, Soil temperature sensors arrive in an assortment of structures utilizing thermistors, thermocouples, thermocouple wires, and averaging thermocouples. The electrical signs transmitted from the sensors to information lumberjacks can be changed over to various units of estimation, including °C , °F, and °K. Information lumberjacks are likewise equipped for estimating most financially accessible soil temperature sensors.

Figure 12– Electrical Conducting [Source: Google]

The WET Sensor has crucial applications in precision horticulture and soil science research and is usable in both soils and growing substrates. It is exceptional in its ability to measure pore water conductivity (ECp), the EC of the water that is available to the plant.

After gathering all the information all the data s redirecting to cloud using API gateway. Thereafter use relevant machine learning algorithm to predict the results.

In this case we use regression neural network machine learning algorithm to predicate the results with co-relationship.

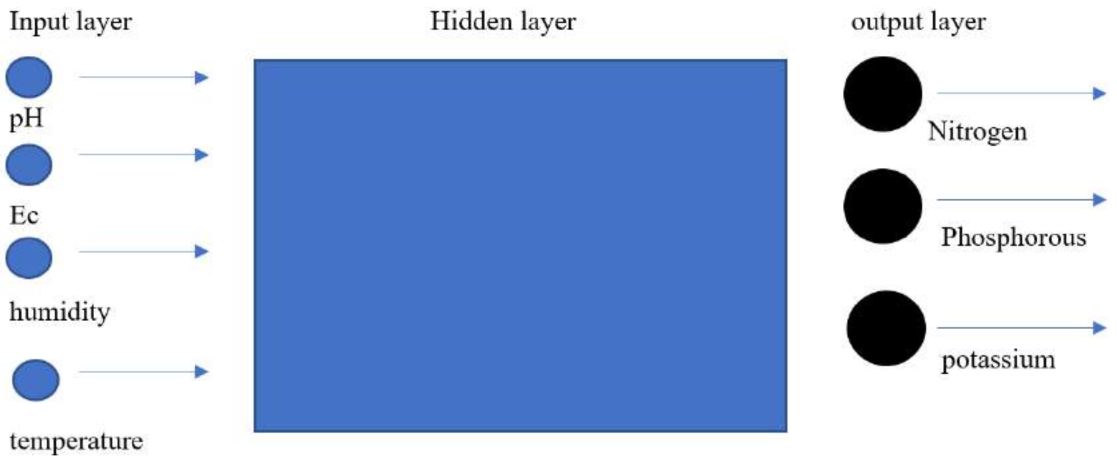


Figure 13 - neural network layers

Using the algorithm, we define co relationship between pH, Ec, humidity and Temperature.

Crop	Area(Acre)	Urea (N)	T.S.P (P)	M.O.K (K)
Corn	2.5	75	100	50
Peanut	1	14	40	30
Mung bean	2.5	30	100	75
Soy Beans	1	50	100	75
Thala	1	20	48	24
Gram	1	14	40	30
Kaupi	1	14	40	30
Kurahan	1	26	22	34

Table 1 - Prepared crop data set[13]

As the proposed system is mainly focuses on to suggest the most suitable crop that can be grown in a particular land, aim of developing fertilizer suggestion module using a relevant machine learning algorithm is to recommend a suitable fertilizer plan for each suggested crop in crop list to minimize excess fertilizer usage and have the maximum harvest on behalf of the money invested.

The below figure will give a clear idea about the flow of recommending chemical fertilizer for app suggested crop list.

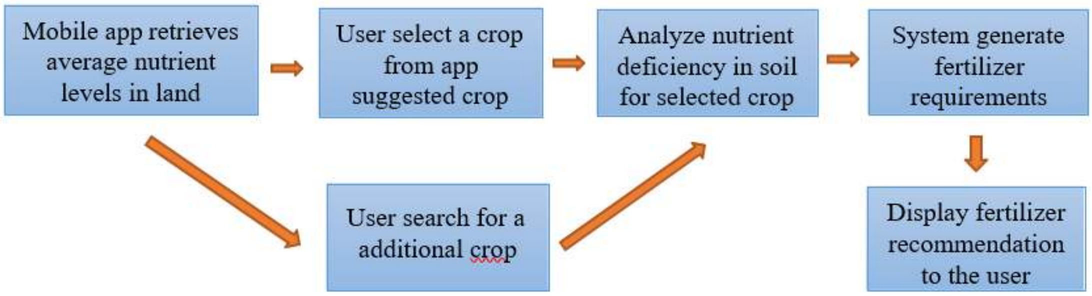


Figure 14 - - Flow of recommending fertilizer amount for app suggested crop list

Authors deployed a cross platform mobile application and it facilitate farmers to select best crop for the land and maintain the growth of the cultivation with a better fertilizer plan. At the beginning farmer has to enter area of the land in meters. Then app automatically suggest the minimum reading count needed to take from the land.

Using the proposed tool farmer has to take reading from the land and when the required reading count is fulfilled, App retrieve sensor reading from the cloud server, calculate average of sensor readings and display existing N, P, K percentages in soil. Then app analyse both soil type and existing nutrient levels in soil with in-built dataset in database and suggest list of most suitable crops that can be grown in the land.

Whenever the farmer selects a crop from app suggested crop list, App retrieve fertilizer amount required to use in to the land for that selected crop using in-built dataset in database. Using the data retrieved, it generates average N, P, K percentages that should exist in that particular land respectively.

$$R = p \times \left(\frac{u}{a} \times m \right) \qquad \text{Eq. (1)}$$

Where,

R - average nutrient percentages that should exist in land

p - amount of a particular nutrient included in 1 Kg of fertilizer

u - amount of fertilizer that should use for the selected crop

a - area retrieved from database in m^2

m - area of land in m^2

By comparing those generated nutrient percentages with soil existing nutrient percentages, nutrient deficiency of that particular land can be obtained. To overcome that deficiency, required amount of fertilizers that should use into that land is recommended.

$$F = f \times (R - e) \qquad \text{Eq. (2)}$$

Where,

F – recommended fertilizer amount

f – fertilizer amount that contain 1 Kg of particular nutrient

R - average nutrient percentages that should exist in land

e – land existing nutrient percentages

If by any chance farmer wanted to grow different crop other than crops included in suggested list, he can search for that crop details. If the requested crop can be grown in the land only by adjusting the existing nutrient levels in soil, app suggest the amount of fertilizer that should be used in order to plant that crop. So the farmer can make the land suitable for that crop to have a better harvest. This also helps to avoid soil degradation since there is no chance to use excess fertilizers.

Because we are trying to keep the track of a plant, we need to store all the data according to the specific crop from the day it was planted. We can check the specific nutrition details the plant needs for a successful cultivation with comparing the sensor readings we get from testing the current soil type in the cloud with the records in the database.

According to the selected crop, we are going to generate a fertilizer plan. It will vary with the soil nutrient levels of the relevant ground at that current time. Each and every crop requires different kinds of fertilizers in different times. The matching fertilizers we can use for the growth of a single crop has so many varieties.

Specific crop has a specific amount of time that should apply the nutrients to the soil for better growth. According to that time period the soil nutrients will be change due to climate changes. So, for the better accuracy we take the soil nutrients with the help of sensor sub system in each time duration.

The below figure will give a clear idea about the flow of predicting the future fertilizer plan for the selected crop.

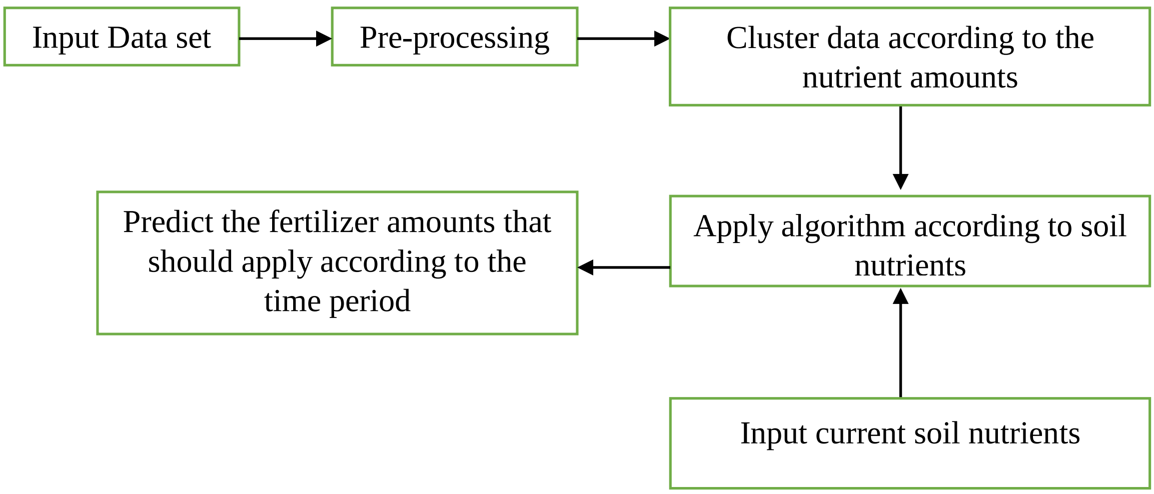


Figure 15-Flow of predicting the fertilizer amounts that should apply according to the time period

Table 2- Application rate of TSP for potato and vegetable crops [9]

Soil P level (mg/kg)	**Application rate of the recommended level**	**Potato**	**Cabbage**	**Tomato**	**Brinjal**
< 20	Full	270	270	270	325
20 – 30	Half	200	135	135	165
>30	Starter dose	70	70	60	85

Table 3 - Application rate of MOP for potato and vegetable crops (kg/ha) [9]

Soil P level (mg/kg)	**Application rate of the recommended level**	**Potato**	**Cabbage**	**Tomato**	**Brinjal**
< 160	Full	250	150	130	170
160 – 400	Half	130	90	90	110
>400	No application	-	-	-	-

Input data set has the specific fertilizers that should apply according to the time period, with respect to the nutrient percentages included in the fertilizer. The collected data will then be pre-processed and divide into different clusters according to the specific N, P, and K amounts of each fertilizer. So, we can have an idea about the total N, P, K amounts in all the fertilizers.

For the processing of predicting the fertilizer plan, we apply deep learning techniques. As the inputs, we are providing the data set and the fertilizer amounts in soil according to the specific time period to the input layer. The hidden layers will maintain the calculations for predicting the specific amounts that should apply from each fertilizer. The output layer will maintain to show the predicted results to the user.

Let the hectares in the ground denotes as h

The specific fertilizer be x

The amount that should apply from each fertilizer be a

Then we can denote the total fertilizer amount that should apply,

$$= h[x_1 * \left(\frac{a_1}{100}\right) + x_2 * \left(\frac{a_2}{100}\right) + x_3 * \left(\frac{a_3}{100}\right) + \cdots + x_n * \left(\frac{a_n}{100}\right)]$$

2.2. Commercialization aspect of the project

In agriculture industry, one of the main concerns faced by the beginners to that field, is that most of them have lack of knowledge of maintaining their cultivation. That causes the farmer not to have a very successful cultivation as they expected. The solution for that problem is given by this product.

The most suitable crop for a specific land and the fertilizer plan that includes the fertilizer types and the amounts according to specific duration will be predict by this product. That leads the farmers to have a better outcome through their cultivation as they expected.

Also this will be a huge benefit to the agriculture industry since it reduces the time and amount of money that a farmer has to spend to test the soil, and it leads people to use this technology more often

2.3. Testing and Implementation

Implementation –

Configuring humidity sensor with Arduino board

```
#include "DHT.h"
#define DHTPIN 2
#define DHTTYPE DHT22

DHT dht(DHTPIN, DHTTYPE);

void setup() {
  Serial.begin(9600);
  Serial.println("DHTxx test!");

  dht.begin();
}

void loop() {

  delay(2000);
  float h = dht.readHumidity();
  float t = dht.readTemperature();
```

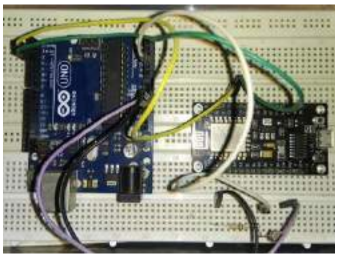
```
  float f = dht.readTemperature(true);

  if (isnan(h) || isnan(t) || isnan(f)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }

  float hif = dht.computeHeatIndex(f, h);
  float hic = dht.computeHeatIndex(t, h, false);

  Serial.print("Humidity: ");
  Serial.print(h);
  Serial.print(" %\t");
  Serial.print("Temperature: ");
  Serial.print(t);
  Serial.print(" *C ");
  Serial.print(f);
  Serial.print(" *F\t");
  Serial.print("Heat index: ");
  Serial.print(hic);
  Serial.print(" *C ");
  Serial.print(hif);
  Serial.println(" *F");
}
```

Configuring pH sensor with Arduino board

```
const int analogInPin = A0;
int sensorValue = 0;
unsigned long int avgValue;
float b;
```

```
int buf[10],temp;
void setup() {
 Serial.begin(9600);
}

void loop() {
 for(int i=0;i<10;i++)
 {
  buf[i]=analogRead(analogInPin);
  delay(10);
 }
 for(int i=0;i<9;i++)
 {
  for(int j=i+1;j<10;j++)
  {
   if(buf[i]>buf[j])
   {
    temp=buf[i];
    buf[i]=buf[j];
    buf[j]=temp;
   }
  }
 }
 avgValue=0;
 for(int i=2;i<8;i++)
 avgValue+=buf[i];
 float pHVol=(float)avgValue*5.0/1024/6;
 float phValue = -5.70 * pHVol + 21.34;
 Serial.print("sensor = ");
 Serial.println(phValue);

 delay(20);
}
```

Connect Arduino to firebase server using ESP8266-



```
#include <SoftwareSerial.h>
SoftwareSerial ArduinoUno(3,2);
int n;
void setup() {
  // put your setup code here, to run once:
  Serial.begin(9600);
  ArduinoUno.begin(4800);

pinMode (3,INPUT);
pinMode (2,OUTPUT);

}

void loop() {
  // put your main code here, to run repeatedly:
  n=analogRead(A2);
   ArduinoUno.print(n);
  ArduinoUno.println("\n");
  Serial.println(n);
  delay(300);
}
```

In order to gather data repeatedly we have used real time data access using a loop so the data set is uploading to fire base server repeatedly 300 seconds.

Machine learning algorithm using-

To create the model, we have used support vector machine algorithm.

Training model

```
import pandas as pd
from random import shuffle
from sklearn.linear_model import LinearRegression
import time
import pickle

cols = ['pH ', 'humidity %', 'ec ', 'temperature', 'n %', 'p %', 'k %']
df = pd.read_excel(r'\Users\nayanalakshitha\Desktop\dataset.xlsx')



pH = df['pH ']
humidity = df['humidity %']
ec = df['ec ']
temperature = df['temperature']
n = df['n %']
p = df['p %']
k = df['k %']

getData = [pH, humidity, ec, temperature, n, p, k]
list1 = []
for k in range(len(getData[0])):
    i = k
```

```
    x = [int(getData[0][i]), int(getData[1][i]), int(getData[2][i]), int(getData[3][i])]
    tot = 0
    for j in range(len(x)):
        tot = float(tot) + x[j]
    x = [int(getData[0][i]) / tot, int(getData[1][i]) / tot, int(getData[2][i]) / tot,
int(getData[3][i]) / tot,
         getData[4][i], getData[5][i], getData[6][i]]
    list1.append(x)

"""
n case
"""

list = list1
totPred = 0
cp = 0
model = None
X = None
Y = None
for i in range(10):
    shuffle(list)
    bigData = pd.DataFrame(list, columns=['', '', '', '', 'label', 't1', 't2'])
    target = bigData['label']
    from sklearn.model_selection import train_test_split

    X_train, X_test, Y_train, Y_test = train_test_split(bigData.drop(['label', 't1', 't2'],
axis='columns'), target,
                                                        test_size=0.2)
    model = LinearRegression()
    X = X_train
    Y = Y_train
```

```
    model.fit(X_train, Y_train)
    pred = model.score(X_test, Y_test)

    if (pred > cp):
        cp = pred
        filename =
r'\Users\nayanalakshitha\PycharmProjects\untitled\venv\nmodel\nModel.sav'
        pickle.dump(model, open(filename, 'wb'))

    totPred = pred + totPred

print("")
print("Algorithm : LinearRegression for n")
print("Train Data Count : ", len(X_train))
print("Test Data Count : ", len(X_test))
print("Accuracy :", cp)

"""
p case
"""

list = list1
totPred = 0
cp = 0
model = None
X = None
Y = None
for i in range(10):
    shuffle(list)
    bigData = pd.DataFrame(list, columns=['', '', '', '', 't1', 'label', 't2'])
    target = bigData['label']
```

```
    from sklearn.model_selection import train_test_split

    X_train, X_test, Y_train, Y_test = train_test_split(bigData.drop(['t1', 'label', 't2'],
axis='columns'), target,
                                                        test_size=0.02)
    model = LinearRegression()
    X = X_train
    Y = Y_train
    model.fit(X_train, Y_train)
    pred = model.score(X_test, Y_test)

    if (pred > cp):
        cp = pred
        filename =
r'\Users\nayanalakshitha\PycharmProjects\untitled\venv\pmodel\pModel.sav'
        pickle.dump(model, open(filename, 'wb'))

    totPred = pred + totPred

print("")
print("Algorithm : LinearRegression for p")
print("Train Data Count : ", len(X_train))
print("Test Data Count : ", len(X_test))
print("Accuracy :", cp)

"""
k case
"""

list = list1
totPred = 0
```

```
cp = 0
model = None
X = None
Y = None
for i in range(10):
    shuffle(list)
    bigData = pd.DataFrame(list, columns=['', '', '', '', 't1', 't2', 'label'])
    target = bigData['label']
    from sklearn.model_selection import train_test_split

    X_train, X_test, Y_train, Y_test = train_test_split(bigData.drop(['t1', 't2', 'label'],
axis='columns'), target,
                                                    test_size=0.2)
    model = LinearRegression()
    X = X_train
    Y = Y_train
    model.fit(X_train, Y_train)
    pred = model.score(X_test, Y_test)

    if (pred > cp):
        cp = pred
        filename =
r'\Users\nayanalakshitha\PycharmProjects\untitled\venv\kmodel\kModel.sav'
        pickle.dump(model, open(filename, 'wb'))

    totPred = pred + totPred

print("")
print("Algorithm : LinearRegression for k")
print("Train Data Count : ", len(X_train))
print("Test Data Count : ", len(X_test))
```

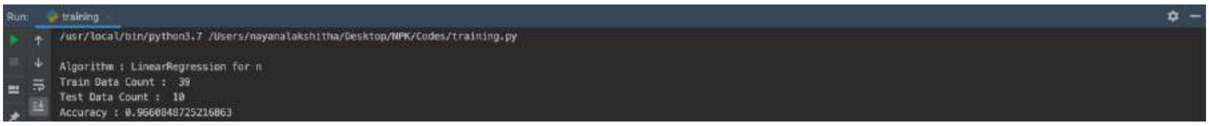
```
print("Accuracy :", cp)
print("")
```

Testing Model

```
import pickle
import pandas as pd
import numpy as np

nmodelfile = r'C:\Users\S\Desktop\NPK\nModel.sav'
pmodelfile = r'C:\Users\S\Desktop\NPK\pModel.sav'
kmodelfile = r'C:\Users\S\Desktop\NPK\kModel.sav'
datafile = r'C:\Users\S\Desktop\NPK\dataset2.xlsx'
savedfile = r'C:\Users\S\Desktop\NPK\prediction.txt'

names = ['pH ', 'humidity %', 'ec ', 'temperature']
nmodel = pickle.load(open(nmodelfile, 'rb'))
pmodel = pickle.load(open(pmodelfile, 'rb'))
kmodel = pickle.load(open(kmodelfile, 'rb'))
df = pd.read_excel(datafile, names=names, header=None)

pH = df['pH ']
humidity = df['humidity %']
ec = df['ec ']
temperature = df['temperature']



def PreProcessData(getData):
    sum = 0
    for i in range(len(getData)):
```

```
        sum = sum + getData[i]
    tList = (pH[0] / sum, humidity[0] / sum, ec[0] / sum, temperature[0] / sum)
    return tList



getData = [pH, humidity, ec, temperature]
tList = PreProcessData(getData)

testdata = pd.DataFrame(tList)
tList = np.array(tList)
tList = tList.reshape(1, -1)
n = nmodel.predict(tList)
print("n : ", n)
p = pmodel.predict(tList)
print("p : ", p)
k = kmodel.predict(tList)
print("k : ", k)

f = open(savedfile, "w+")
f.write(str([n[0], p[0], k[0]]))
f.close()
print("text file Done")
```

2.3.Results

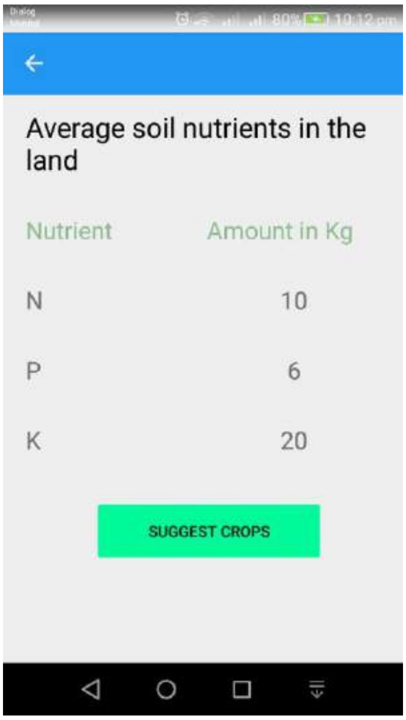


Run: training
/usr/local/bin/python3.7 /Users/nayanalakshitha/Desktop/NPK/Codes/training.py
Algorithm : LinearRegression for n
Train Data Count : 39
Test Data Count : 10
Accuracy : 0.9660848725216863

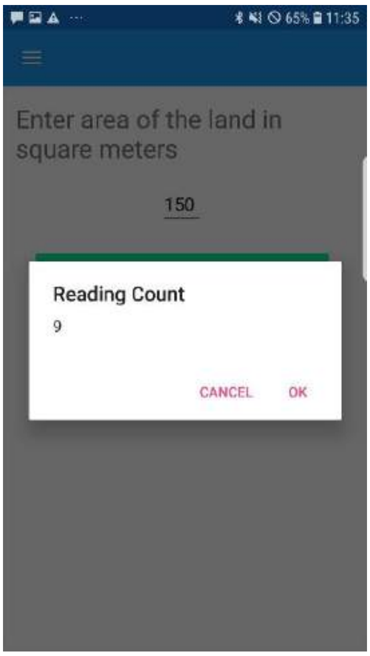
Algorithm : LinearRegression for p
/Library/Frameworks/Python.framework/Versions/3.7/lib/python3.7/site-packages/sklearn/metrics/regression.py:543: UndefinedMetricWarning: R^2 score is not well-defined with less than two samples
Train Data Count : 48
warnings.warn(msg, UndefinedMetricWarning)
Test Data Count : 1
/Library/Frameworks/Python.framework/Versions/3.7/lib/python3.7/site-packages/sklearn/metrics/regression.py:543: UndefinedMetricWarning: R^2 score is not well-defined with less than two samples
Accuracy : 0
warnings.warn(msg, UndefinedMetricWarning)

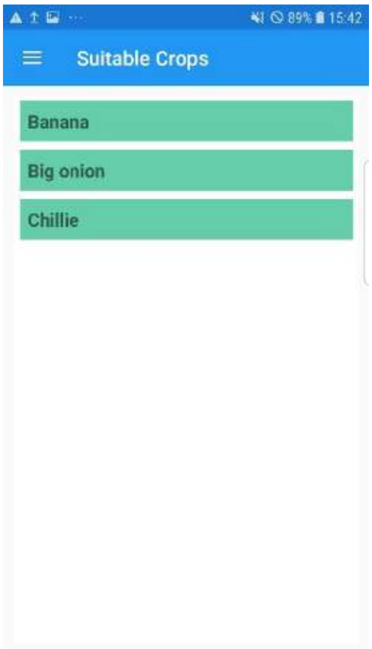
Run: training
UndefinedMetricWarning: R^2 score is not well-defined with less than two samples
Accuracy : 0
warnings.warn(msg, UndefinedMetricWarning)
Algorithm : LinearRegression for k
Train Data Count : 39
Test Data Count : 10
Accuracy : 0.9571685808154554
Process finished with exit code 0

Run: test
/usr/local/bin/python3.7 /Users/nayanalakshitha/Desktop/NPK/Codes/test.py
UserWarning: Trying to unpickle estimator LinearRegression from version 0.19.1 when using vers
UserWarning)
n : [98.94829658]
p : [94.]
k : [101.05935685]
text file Done
Process finished with exit code 0



Final main outcome of the project is predicting crops for desired land. There is a small display to view pH, EC, Temperature & humidity levels of soil. All data goes to cloud to process the data from sensors in order to obtain N, P, K levels of soil. Processed data goes to subsystems to obtain other outcomes from the system.





After user entered the land area, required reading that should be taken from the land is suggested by the mobile app and if the required reading count has taken from the land by user app display average N, P, K values available in land. According to them, suitable crop list is suggested. When user select a crop from app suggested crop list, nutrient deficiency in the land for that particular crop and suitable fertilizer amount will be recommended by the mobile app in order to overcome from that nutrient deficiency.

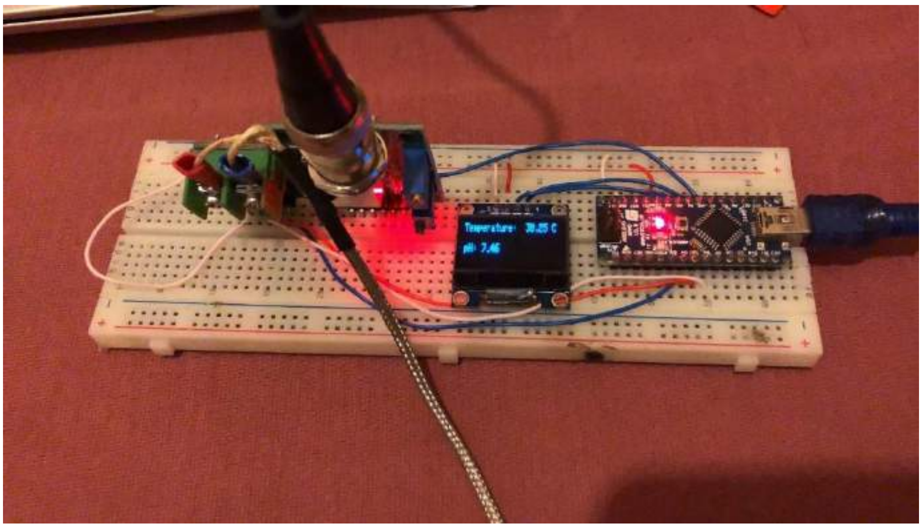


Figure 16 –Final product

CONCLUSION

Soil testing mechanism is still a time consuming and hard work process in Sri Lanka. Therefore, using a smart device to get readings and analysis is a much-needed way instead of typical lab testing.

All together smart soil testing device needed to be implemented estimate fertility status of soil, analyzing soil fertilizer level with particular plant recommended fertilizer level and give most suitable fertilizer plan for future growth in plants. It is a great opportunity for farmers using a smart device to get a right direction for cultivate best matching crop in best matching soil state.

Our contribution here is using machine learning algorithms to analyze and give the best predictions for fertilizer level mainly. Support vector machine learning algorithm is the main machine learning algorithm which using here to achieve best result.

Gaining best result is not just the only thing needed to be implemented by smart device therefore, using multiple algorithms to check whether what will give the most accurate and quick result using data set is needed.to retrieve results more quickly using techniques such as data mining is really important because of working with lack of data sets.

Also, smart device should be a simple device which can use by people who doesn't have better knowledge about either English language or technical knowledge. Therefore, device and the mobile app should be simple to find the things easier with user friendly manner is highly recommended.

Other than those main recommendations this kind of devices are work with agricultural environment therefore they are easily meeting water and dust environment so it is mandatory to build the device with water and dust resistance.

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